DOCUMENT RESUME

ED 172 784 IR 007 417

AUTHOR Clark, Francis E.; Angert, Jay F.
TITLE Research on Media--Where Do We Go From Here?
PUB DATE Mar 79
NOTE 19p.; Paper presented at the Annual Convention of the Association for Educational Communications and Technology (New Orleans, Louisiana, March 1979); For related document, see IR 007 416

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Educational Environment; *Educational Research; Individual Characteristics; *Instructional Design; *Media Research; *Research Problems; Teacher Characteristics
IDENTIFIERS *Aptitude Treatment Interaction

ABSTRACT

A summarization of media research inadequacies remains a standard feature of media literature reviews. A Gestalt solution would be a research model, applicable to field studies in educational institutions, which accounts for the total instructional setting. It appears that an appropriate research model must be directly related to the psychological, sociological, and physiological attributes of the learner, the teacher, the task, and the resources, which collectively result in an instructional environment. The objective form (physiological) and subjective meaning (sociological) of any learning task must yield a functional distinctiveness (psychological) in terms of the sensory information to be extracted by the learner. (Author)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED172784

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY

Title • RESEARCH ON MEDIA -- WHERE DO WE GO FROM HERE?

Authors • FRANCIS E. CLARK
Texas A&M University

• JAY F. ANGERT
Texas A&M University

Abstract • A summarization of media research inadequacies remains a standard feature of media literature reviews. A Gestalt solution would be a research model, applicable to field studies in educational institutions, which accounts for the total instructional setting. It appears that an appropriate research model must be directly related to the psychological, sociological, and physiological attributes of the learner, the teacher, the task, and the resources, which collectively result in an instructional environment. The objective form (physiological) and subjective meaning (sociological) of any learning task must yield a functional distinctiveness (psychological) in terms of the sensory information to be extracted by the learner.

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

Michael Simonson

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC) AND USERS OF THE ERIC SYSTEM."

IR007417

RESEARCH ON MEDIA -- WHERE DO WE GO FROM HERE?

FRANCIS E. CLARK
Texas A&M University
JAY F. ANGERT
Texas A&M University

A summarization of media research inadequacies remains a standard feature of literature reviews. A serious reader of the research literature for the past ten years will encounter numerous depressing appraisals of the limited value of media research for improving education. Although many reviewers have decried the uncertain quality and utility of media research, an exhaustive litany of futility is unnecessary. The comments which follow are sufficiently illustrative.

Research Deficiencies

In 1968, Snow and Salomon remarked that "virtually nothing is known . . . about the teaching effectiveness of instructional media" (p. 341). This conclusion was based, in part, on their observation of the widespread use of experimental designs which averaged individual learner differences, although the prime importance of these differences as independent variables had been previously noted (Cronbach, 1957). Comstock (1975) similarly concluded that the utility of media research for either theory or practice was inconsequential. In addition, research with, as opposed to research on media, has been the rule rather than the exception (Salomon, 1970). Researchers have repeatedly treated a given medium as a whole entity, as in comparison studies of film versus television, in an attempt to support the premise that the media could indeed teach. Fleming (1970) recognized that such gross comparisons

3

yielded meaningless data since they masked considerably more variability than they explained. In 1977, Schramm described this macro quality as perhaps the most regrettable feature of the long list of instructional media experiments. Levie and Dickie (1973) suggested that research would be better conceptualized by specifying media variables in terms of specific attributes. Finally, Conway (1970) and Dwyer (1972) have identified as a major research deficiency the lack of logical correlations between the treatment content encountered in many studies and that typical of actual classroom instruction. Glaser (1972) and Salomon and Snow (1970) have also noted the pressing need for "ecological validity," i.e., experimentation under normal instructional conditions.

Perhaps the most brutally frank assessment of media research was offered by Hawkridge (1973):

> The fact is that instructional researchers and designers have not provided even the foundations for constructing strong practical procedures for selecting media appropriate to given learning tasks. If there has been British work in this area, I have been unable to discover it . . . . In the United States, over 2000 media studies have not yielded the answers we need. (p. 1)

Taken at face value, these assessments imply a great deal of misdirected energy, over a lengthy time span, to establish a data base of questionable value.

ATI as a Solution

The widespread recognition that media research had failed to attend to individual learner differences prompted repeated calls for employing the methodology known synonomously as Trait-Treatment Interaction (TTI), or Aptitude-Treatment Interaction (ATI), hereinafter referred to simply as ATI (Allen, 1971; Berliner and Cahen, 1973; Cronbach, 1957; Cronbach and Snow, 1977; DiVesta, 1975; Snow and Salomon, 1968; Virag, 1976). Within this context,

aptitudes or traits are defined broadly enough to include the psychological, sociological and physiological characteristics of learners. Cronbach and Snow (1977) suggested that any aspect of an individual which may be useful in predicting instructional responses should be considered an "aptitude." Treatments are defined in a similarly broad fashion so as to include variations among most experimentally manipulable aspects of the teaching or the environment.

Interactions may be defined statistically as regression slopes which depart from parallelism. A disordinal interaction suggests that different treatments are differentially superior for students who are at different levels of a particular trait or aptitude. An ordinal interaction, however, suggests that one treatment retains its superiority over an alternate treatment throughout the range of aptitudes under consideration. However, this superiority is usually more pronounced at one level of the aptitude than at others (Ott, 1977; Cronbach and Snow, 1977).

Adaptations in education to individual differences are neither new nor difficult to find. Considering the obvious extent to which the educational community has accepted instructional and programmatic practices geared to individual differences, the concerted research efforts to locate educationally relevant ATI surficially makes eminent good sense. It is intellectually difficult to deny that ATI's exist. To do so is tantamount to asserting that the instruction which works best for one group of students is therefore best for all students (Cronbach and Snow, 1977).

Paradoxically, it is the firm belief in human individuality and instructional diversity which has so complicated ATI research. As Cronbach (1975) stated, "Once we attend to interactions, we enter a hall of mirrors which

extends to infinity . . ." (p. 119). The greatest difficulty ATI researchers have faced is the isolation of those aptitudes and treatment conditions, from an unknown universe of differences, which reliably interact with particular instructional treatments to produce predictable learning outcomes. Considering the immensity of the task, and the relative infancy of the technique, it is hardly surprising that ATI results have been disappointing (Bracht, 1970; Cronbach and Snow, 1977; Dwyer, 1978; Heidt, 1977; Parkhurst, 1975). Undeniably, ATI results have been less than spectacular. The range of aptitudes and treatments is so vast that researchers have had a veritable field day in devising researchable combinations. A search for ATI's calls for no less than a survey of all the ways in which individuals and instructional treatments may differ. These constructs may pair up to form virtually limitless ATI hypotheses (Cronbach and Snow, 1977). The result has been a bewildering array of studies with relatively few threads of commonality.

In the face of such diversity, the temptation is great to use a shotgun approach in searching for ATI's. Salomon (1971) has noted a tendency on the part of many ATI researchers to include extremely large numbers of trait measures in their studies, in the hope of discovering some interactions. Such interactions, even when found, are weak in their explanatory power, having arisen atheoretically and from an inadequate conceptualization of the traits. For the most part, this broad-band exploration approach has not been successful.

Attempts to integrate the fragmentary ATI results have met with only limited success. Allen (1975) concluded that generalizing from the available results was virtually impossible. The similarity of his comments to those of Hawkridge was striking: ". . . there is little definitive evidence from the

aptitude-treatment interaction research that points conclusively to the employment of practices that might guide the selection of the more general instructional strategies, much less lead to the design of specific instructional media" (p. 139). Dwyer (1978) and Parkhurst (1975) have also noted the limited usefulness and meaningfulness of ATI research to date. In the summary of what is undoubtedly the seminal work for research on interactions, Cronbach and Snow (1977) concluded that "No Aptitude X Treatment interactions are so well confirmed that they can be used directly as guides to instruction" (p. 492).

Numerous methodological problems have plagued the search for ATI (Cronbach and Snow, 1977). Quite often, however, investigations which have paid close attention to acceptable methodology and data analysis have frequently paid inadequate attention to the more subtle, but equally vital, manner in which the particular constructs chosen as dependent and independent variables complement one another. Thus, a large portion of the media research shortcomings has stemmed from an inadequate conceptualization of pertinent variables. Snow (1970) pointed out the inappropriateness of the majority of constructs in differential psychology for use in ATI research. Cronbach and Snow (1969) previously cited the need for new conceptualizations of traits and treatments. However, both past and present admonishments have largely gone unheeded.

The ATI research literature is so disparate and contradictory that reviewers find themselves in disagreement over its proper interpretation. How is one to make sense out of a body of research which fails to produce interactions where hypothesized, produces interactions in unanticipated and inexplicable fashion, and which may or may not replicate interactions in

7

subsequent studies? Heidt (1977) stated that "To prove a trait-treatment interaction, it is necessary to detect a disordinal interaction . . ." (p. 13). Heidt further concluded that the ATI results are so inconsistent that general summarization is impossible. Berliner and Cahen (1973), however, argued that ordinal interactions are as useful in ATI research as disordinal. Contrasting reviewer techniques have further muddied the waters. Of the ninety studies which Bracht examined, only five were adjudged as giving adequate evidence of ATI, since they produced disordinal interactions. Cronbach and Snow (1977), however, regarded Bracht's criteria as overly stringent and, in a reexamination of several studies dismissed by Bracht as failing to show ATI's, found disordinal interactions.

As different as non-ATI and ATI research are from one another in methodology and philosophy, it is interesting to note that many of the criticisms leveled against non-ATI research are equally applicable to the newer methodology. To the extent that these inadequacies persist, confusion will still reign. In 1970, Shulman warned against research which measured aptitudes with micrometers but environments with divining rods; yet critics are still decrying the unprofitability of using gross aptitude and treatment measures (Anderson, Ball, and Murphy, 1975; Cronbach and Snow, 1977; Dwyer, 1978). According to Dwyer (1978), unrealistic treatment content is still being experimentally varied under artificial pedagogical conditions (Salomon and Clark, 1977). Methodological problems (e.g., inadequate sample sizes and data analyses, and only rare replications), continue to hamper ATI efforts (Berliner and Cahen, 1973; Cronbach and Snow, 1977).

These difficulties have led every reviewer of ATI literature we have encountered to paint a depressingly familiar picture of ineffectiveness.

All, however, have been loathe to suggest abandoning the effort and, surprisingly, have reached somewhat optimistic conclusions on the heels of pessimistic reviews. Perhaps the single most pervasive shortcoming of ATI research efforts that we have detected is the lack of inclusiveness, i.e., collective inattention to the totality of the learning environment. The term Aptitude-Treatment Interaction by itself denotes an overly simplistic two-dimensional conception of learning environments and has perhaps engendered a delimited focus among some researchers. ATI investigations have provided a forum for researchers to promote a spectrum of variables covering learner, teacher, and treatment characteristics; environmental or situational conditions; and a variety of resource characteristics. If research is to proceed systematically toward usable conclusions, some semblance of order must be imposed on the mass of ATI hypotheses. To date, research has been conducted from each researcher's conception of fundamental combinations of attributes. However, we are unaware of a research model which effectively relates these diverse attributes.

The literature is replete with suggestions. Carpenter (1972) called for a blend of media and modes, instructional functions and objectives, content and audience characteristics, and learning environments, while Clark (1975) stressed the relationship between instructional methods, materials, and individual aptitudes. DiVesta (1975) suggested concentrating on cognitive processing variables, whereas Salomon (1976) argued that a presentation's effectiveness depended on a match of mental skills activated by the presentation's code and the learning task requirements. Finally, Burns (1976) suggested a blend of learner, media and environmental variables, while Schramm (1977) pointed out the need for studies of the content of instructional media.

While these varied recommendations have meritorious features, they reflect both an obvious lack of common terminology and a vast disagreement on a comprehensive model from which research on instructional media selection should proceed.

A Practitioner/Researcher Continuum

Since the empirical data have not provided clear research directions, we are faced with a body of literature from which it is difficult to extract "general" principles. Thus, we will need to extrapolate from a broad spectrum of models, paradigms, classification systems, and hierarchies. In this way we may be able to identify the common denominators of the current literature. Any resulting research model would, of necessity, be eclectic in nature.

While it may be true that there is nothing so practical as a good theory, it is also true that much theorizing has little relationship with practicality. Instructional researchers would do well to adopt, adapt, and apply the eclectic instructional practices of "successful" instructors to the design of instructional research. Undeniably, a considerable amount of classroom instruction, devoid of experimental controls or constraints, frequently produces learning of practical significance. One possible explanation may lie in the holistic approach which is characteristic of the "effective" instructor, but which, philosophically, is worlds apart from most research efforts. Intuitively, many instructors manage to derive an optimal blend of personal style, learner and resource characteristics, and task requirements through a consideration of psychological, sociological, and physiological factors.

All too frequently, however, the researcher operates from a narrowly circumscribed perspective. This tunnel vision tendency leads to narrowly

conceived research hypotheses. These hypotheses, in turn, engender explanations of data in terms which either sustain or modify the philosophic bent of a particular researcher. Rarely are philosophic lines crossed to acknowledge equally valid or potentially superior explanations of observed learning outcomes. This omission is true both across and within disciplines. The field of educational technology serves as an appropriate example.

We assert that past media research has been philosophically dichotomous, arising either from practitioner or researcher concerns. Becker (1977) described how such artificial distinctions have excluded consideration of many important variables. Not surprisingly, the various media selection models have closely paralleled these media research directions. Mielke (1973) referred to this separation as the distinction between administrative research and basic research, and Clark (1975) extended this distinction to most media taxonomies.

An Eclectic Model for Research and Instruction

To a large extent, commitment to preferred statistical methodology has also dictated research directions. Usually, investigators have dealt with one or two instructional variables at a time, either in a search for main effects or for interactions. To this end, researchers have used regression analysis and other sophisticated statistical techniques to analyze fairly unsophisticated subjective measures of attributes or traits. For these reasons, statistical trends have failed to produce the consistency needed for the development of an instructional model.

Considering the unproductive history of research on instruction, it seems appropriate to step back and take a second look at the diverse research

directions which have been, to a great extent, independent of one another. While we recognize that research frequently transcends artificial boundaries, we nevertheless submit that most research on instruction may be categorized loosely into three major areas. We feel that these areas closely parallel the considerations of the effective instructor described earlier.

The first area may be termed functional and/or differential psychological research. This area deals primarily with intellectual abilities, as well as the relationships among stimuli, mediating covert behaviors, and observable overt responses. More precisely, researchers within this domain of research usually begin with a psychological theory and then proceed to validate the logically derived statements, in the form of constructs, through schemes for organizing data for quantitative analysis. The following schemes are usually thought to be synonomous: theory, model, paradigm, analogy, structure, hierarchy, and system. E. L. Thorndike, J. P. Guilford, R. M. Gagné, B. S. Bloom, D. P. Ausubel, L. S. Briggs, G. A. Salomon, L. J. Cronbach, L. L. Thurstone, R. M. W. Travers, R. E. Clark, B. F. Skinner, C. E. Osgood, and G. L. Gropper are some of the researchers who have followed this line of research.

A second area deals with observational and/or sociological research. Researchers in this area acknowledge the notion that individuals can learn to perform some physical and social tasks by imitating the overt behaviors of a "model." This research area includes the humanistic, cultural, ethic, ethnic, ego and consistency needs of individuals when they are alone or in groups. This area also encompasses instructional cognitive styles which may be cultural and social preference systems acquired and supplemented during schooling (Heidt, 1977). Some of the proponents of the sociological approach to instruction include the following: A. Bandura, G. F. Kuder, E. K. Strong, G.

W. Allport, H. A. Witkin, N. Flanders, W. F. Seibert, R. E. Snow, R. R. Sears, A. H. Maslow, C. Buhler, and E. H. Erikson.

The third area is defined as physiological research. Within this area lies the subjective research on perception, on the form and structure of sensory messages, and on the constant interaction between the person and the environment. The biological bases of knowledge contain the roots of this major area. Research in this domain has dealt with the developmental characteristics of individuals as they interact, through the sensory channels, with the instructional environment. S. H. Bartley, C. B. DeSoto, J. J. Gibson, M. L. Fleming, J. Piaget, A. Gesell, R. J. Havighurst, H. Werner, M. Montessori, D. Durkin, V. Lowenfeld, F. M. Dwyer, and A. A. Lumsdaine are some of the researchers who have contributed to this area of study.

It appears that an appropriate research model must be directly related to the psychological, sociological, and physiological attributes of the learner, the teacher, the task, and the resources, which collectively result in an instructional environment. A Gestalt solution would be a research model, applicable to field studies in educational institutions, which accounts for the total instructional setting. If learning is the ultimate product of the instructional environment, then the instructional environment is the product of the interaction within, between, and among the teacher, the learner, the task, and the resources. One of the problems involved in a discussion of our instructional model is that the variables are not, unfortunately, as mutually exclusive as we would like for them to be. We are viewing instruction as a dynamic process in which the variables of instruction play an integral but subordinate part. Of greatest importance are the unique psychological, sociological, and physiological relationships within, between, and among the

variables. We maintain that relationships between stimuli and responses are best predicted from information about the intermediary processes that occur within the individual. It is not unreasonable to suppose that the learner has developed general dispositions for processing stimulation based upon the daily activities associated with communicating, perceiving temporal and spatial relations, and problem solving. The learner must adapt himself to the learning environment in order, ultimately, to learn. Our model, then, is deduced from the psychological, sociological, and physiological makeup of the learner and his surroundings. To use Dale's (1969) "Cone of Experiences" as a simplistic example, if the learning environment is too "concrete," the learner will be under stimulated; if overly "abstract," the learner will be overwhelmed. In either case, it is quite likely that the learner will not reach the objective of the learning task. The implication sought here is that, in order to provide a functional relationship within, between, and among the variables of instruction, communications problems involving syntactics (interrelations of signs), semantics (meanings attributed to signs), and pragmatics (human reactions to signs) must be minimal. Hence, the objective form (physiological) and subjective meaning (sociological) of the learning task must yield a functional distinctiveness (psychological) in terms of the sensory information to be extracted by the learner.

Internal consistency within each variable of instruction is achieved only when the psychological, sociological, and physiological attributes are encoded and decoded in harmony. While it may be unrealistic to attempt to reduce the complexities of human nature to purely numerical terms, it seems worth emphasizing that, if viewed in the manner we have described, there is a potential of seven interactions within each variable of instruction for

any given learning task. Carried further, the potential interactions among the variables of an instructional environment, comprised of the learner, the teacher, the task, and the resources, may be derived, in conservative mathematical terms, as approximately three million total interactions (Hoel, Port and Stone, 1971). Since these permutations are based upon one learner, rather than a class or cell of twenty or more learners, the implications are explicit. At any rate, these concomitant considerations serve to illustrate the complexity of any given instructional environment. The complexity is magnified still further by the fact that perceived dynamic internal and external attributes, that seem to be uniquely associated with the variables of the learning environment, are not always accurate reflections of the actual unique attributes. Over time, and through controlled research, the actual unique attributes for different learning environments may mainfest themselves as a subset of the perceived attributes. There is still, however, an additional complication, i.e., that either perceived or actual attributes may evolve, change, or disappear during the course of instruction or experimentation either due to maturation or due to interaction with other elements of the instructional environment. In the light of these considerations, it seems particularly apt to note that Cronbach (1975) said ". . . the line of investigation I advocated in 1957 no longer seems sufficient. Interactions are not confined to the first order; the dimensions of the situation and of the person enter into complex interactions" (p. 116).

Where Do We Go From Here?

It would seem that the need exists for an instructional model that incorporates the past, present, and future researchable directions. This is

15

not to say that future researchers will agree that the postulated relationships in vogue today are researchable tomorrow. Nonetheless, it may be possible to use the model discussed hereinbefore as a foundation or datum plane upon which a logical rationale could be based for future meta-analyses. At the same time, psychological, sociological, and physiological measuring instruments and/or inventories with veridical comparisons should be identified and/or developed in an attempt to differentiate the unique attributes from the common and the static attributes from the dynamic. As a result, functional experimental research investigating the interrelationships of the variables of instruction will, in the future, be equipped to employ realistic rational controls so that experimenters may more reliably explain that which actually happened.

Most contemporary researchers would agree that we need to know more about the physical and psychological attributes of resources. Heidt (1977) suggested that the unique psychological attributes of resources may be a product of the physical attributes for specific learning experiences. We submit that a similar subset of unique sociological attributes should also be specified since they influence, and are influenced by, the unique psychological and physiological attributes. To extend this idea, the subsets should also be comparable to all of the variables of instruction, and not just to the resources.

In conclusion, it seems reasonable to believe that a logically deduced amalgamation of all research in the behavioral sciences could result in one or more axiomatic theories for instruction. Once derived, selected constituent attributes could be held constant while, at the same time, systematically varying others. Until this is accomplished, research on instructional media will remain omnibus, composed of complex and multivariate aspects of what might be termed "impulsive reckoning."

Selected References

Allen, W. H. Instructional media research: Past, present and future. *AV Communication Review*, 1971, *19*, 9-18.

Allen, W. H. Intellectual abilities and instructional media design. *AV Communication Review*, 1975, *23*, 139-170.

Anderson, S. B., Ball, B. and Murphy, R. T. *Encyclopedia of Educational Evaluation*. Washington, D.C.:Jossey-Bass Publishers, 1975.

Becker, A. D. Alternate methodologies for instructional media research. *AV Communication Review*, 1977, *25*, 181-194.

Berliner, D. C., and Cahen, L. S. Trait-treatment interaction in learning. In F. N. Kerlinger (Ed.), *Review of Research in Education: 1*. Itasca, Ill.:F. E. Peacock, 1973.

Bracht, G. H. Experimental factors related to aptitude-treatment interactions. *Review of Educational Research*, 1970, *40*, 627-645.

Burns, R. W. Instructional television, interaction, and learning objectives. *Educational Technology*, 1976, *16*, 44-49.

Carpenter, D. R. The application of less complex instructional technologies. In W. Schram (Ed.) *Quality in Instructional Television*. Honolulu:The University Press of Hawaii, 1972.

Clark, R. E. Constructing a taxonomy of media attributes for research purposes. *AV Communication Review*, 1975, *23*, 197-215.

Comstock, G. *Television and Human Behavior: The Research Horizon, Future and Present*. Rand Corporation Publication R-1748-CF (Santa Monica, California, June 1975).

Conway, J. K. Forms of information representation and cognitive operations. In G. Salomon and R. E. Snow (Eds.) *Viewpoints* (Bulletin of the School of Education, Indiana University, 1970, *46*, 154-164.

Cronbach, L. J. The two disciplines of scientific psychology. *The American Psychologist*, 1957, *12*, 671-684.

Cronbach, L. J. Beyond the two disciplines of scientific psychology. *American Psychologist*, 1975, *30*, 116-127.

Cronbach, L. J. and Snow, R. E. Individual differences in learning ability as a function of instructional variables. *USOE Final Report*, Contract No. OEC-4-6-061269-1217. Stanford:Stanford University, School of Education, 1969.

Cronbach, L. J. and Snow, R. E. *Aptitudes and Instructional Methods*. New York:Irvington, 1977.

Dale, E. *Audiovisual methods in teaching.* Third edition. New York: Holt, Rinehart and Winston, 1969.

DiVesta, F. J. Trait-treatment interactions, cognitive processes, and research on communication media. *AV Communication Review,* 1975, *23,*185-196.

Dwyer, F. M. *A Guide for Improving Visualized Instruction.* State College, Pa.:Learning Services, 1972.

Dwyer, F. M. *Strategies for Improving Visual Learning.* State College, Pa.:Learning Services, 1978.

Fleming, M. L. Media research prospects: Considerations from a perceptual point of view. In G. Salomon and R. E. Snow (Eds.) *Viewpoints* (Bulletin of the School of Education, Indiana University), 1970, *46,* 119-136.

Glaser, R. Indivduals and learning: The new aptitudes. *Educational Researcher,* 1972, *1,* 5-13.

Hawkridge, D. G. Media taxonomies and media selection. Paper prepared for the Institute of Educational Technology. The Open University, Milton Keynes, England, 1973.

Heidt, E. U. Media and learner operations: The problem of a media taxonomy revisted. *British Journal of Educational Technology,* 1977, *8,* 11-26.

Hoel, P. G., Port, S. C., and Stone, C. J. *Introduction to Probability Theory.* Boston:Houghton Mifflin Company, 1971.

Levie, W. H. and Dickie, K. E. The analysis and application of media. In R. M. W. Travers (Ed.) *Second Handbook of Research on Teaching.* Chicago:Rand McNally College Publishing Company, 1973, 858-882.

Mielke, K. W. Research and evaluation in educational television. In A. Coldarci and R. Arnove (Eds.), *Educational television: A policy critique and guide for developing countries.* A report to the Ford Foundation, Stanford, California:School of Education, Stanford University, 1973.

Ott, L. *An Introduction to Statistical Methods and Data Analysis.* Belmont, California:Wadsworth Publishing Company, Inc., 1977.

Parkhurst, P. E. Generating meaningful hypotheses with aptitude-treatment interactions. *AV Communication Review,* 1975, *23,* 171-196.

Salomon, G. What does it do to Johnny? In G. Salomon and R. E. Snow (Eds.) *Viewpoints* (Bulletin of the School of Education, Indiana University), 1970, *46,* 33-62.

Salomon, G. Heuristic models for the generation of aptitude-treatment-interaction hypotheses. Paper presented at the Meeting of the American Educational Research Association, New York, February 1971.

Salomon, G. A cognitive approach to media. *Educational Technology*, 1976, *16(5)*, 25-28.

Salomon, G. and Clark, R. E. Reexamining the methodology of research on media and technology in education. *Review of Educational Research*, 1977, *47*, 99-120.

Salomon, G. and Snow, R. E. Summary and some reflections on the conference. In G. Salomon and R. E. Snow (Eds.) *Viewpoints* (Bulletin of the School of Education, Indiana University), 1970, *46(5)*, 183-199.

Schramm, W. *Big Media, Little Media.* Beverly Hills, Ca.:Sage Publications, Inc., 1977.

Shulman, L. S. Reconstruction of educational research. *Review of Educational Research*, 1970, *40*, 371-396.

Snow, R. E. Research on media and aptitudes. In G. Salomon and R. E. Snow (Eds.) *Viewpoints* (Bulletin of the School of Education, Indiana University), 1970, *46(5)*, 63-89.

Snow, R. E. and Salomon, G. Aptitudes and instructional media. *AV Communication Review*, 1968, *16*, 341-357.

Virag, W. F. Effectiveness of three instructional modes employed to transmit content to students with different aptitude patterns. In P. J. Sleeman and D. M. Rockwell (Eds.) *Instruction Media and Technology*. Stroudsberg, Pa.:Dowden, Hutchinson and Ross, Inc., 1976.